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Experiments in Technology Assessment for International Development: What Are the Lessons for Institutionalisation?

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Several countries across the OECD have a relatively strong history of using technology assessment (TA) to inform science, technology and innovation (STI) policies. But many lower income, developing countries lack the capabilities and institutions for doing so. Despite its more general potential role in this area, TA has been used relatively little (in or outside the OECD) to inform and challenge investments and policies that address international development objectives. This paper discusses two case studies in which non-governmental TA exercises have focussed on international development objectives in and across lower income countries. Both have made particular efforts to include broader perspectives in the TA process. The paper asks what we can learn from these networked "experiments" and explores possibilities for further institutionalisation of TA for international development.

1 Introduction

International organisations (see e.g. UN System Task Team 2012) often point to key roles for science, technology and innovation (STI) in helping to foster sustainable and inclusive development. This includes moves towards a "green economy in the context of poverty alleviation and sustainable development" discussed at the 2012 Rio+20 conference (UNEP 2011) and to other international development objectives such as the effective implementation of the UN Framework Convention on Climate Change (UNFCCC), maintaining progress towards millennium development goals (UNDP 2011) and the formulation and realisation of sustainable development goals (OWG-SDGs 2014).

Annual global expenditure on research and development continues to grow beyond one tril-

lion dollars. The current systems of governance mean, however, that only a small proportion of this investment is focussed on challenges to international development. Even when investments explicitly focus on development objectives, their wider long-term efficacy is often in question (STEPS Centre 2010). This is because the existing efforts are steered by powerful incumbent interests, which are often misaligned with those of the most vulnerable groups and frequently fail fully to account for social, technical and ecological complexities and uncertainties. Given these conditions, how can the oft-cited potential of STI in attaining these goals be better realised?

Technology assessment (TA) can directly address these challenges. As defined here, TA is a broad set of practices aimed at informing, shaping and prioritising technology policies and innovation strategies by deliberately appraising in advance their wider social, environmental and economic implications. The aim of this paper is to help us understand how TA can address the imperatives discussed above. It provides examples of initiatives that have attempted to do so and explores specific ways in which these kinds of initiatives may be institutionalised. To do this, we first describe the changing approaches to TA in the OECD and in developing countries over the past four decades. Drawing on evidence from two case studies, we analyse how particular aspects (especially the broadening out of inputs to TA and the opening up of the outputs of TA, discussed in more detail by Ely et al. 2014) have allowed some initiatives at the national or international levels to address some shortcomings in existing patterns of innovation. These findings raise significant practical issues for future TA initiatives, especially as these relate to the harnessing of science and technology for international development.

2 Debates Around Technology Assessment Across the OECD: Towards Broadening Out and Opening Up

TA emerged in the 1960s and was first institutionalised in the United States Office of Technology Assessment (OTA) in 1972, and subsequently in several other OECD countries (van Zwanenberg et al. 2009). These institutions arose partly in response to political controversies around technologies such as civilian nuclear energy. They were seen by proponents as providing unbiased analysis of the impact of a technology, usually to Congress or parliament. Typically offered directly to political decision-makers, the aim was to guide public decisions about which technologies should receive state support. Brooks argued that "ideally the concept of Technology Assessment is that it should forecast, at least on a probabilistic basis, the full spectrum of possible consequences of technological advance, leaving to the political process the actual choice among the alternative policies in the light of the best available knowledge of their likely consequences" (Brooks 1976). However, arguments have been made since the outset that this kind of forecasting is neither practically achievable nor neutral and objective.

In practical terms, it has long been recognised that the open, path-dependent dynamics of innovation (Nelson/Winter 1982; Rosenberg 1982) implicate deeper and more intractable forms of uncertainty than it is possible to address in the probabilistic approaches of risk assessment advocated in Brooks' argument. An extensive literature has illuminated contrasting states of "uncertainty" – where probabilities are not known (Knight 1921); "ambiguity" – where there is disagreement over defining, ordering or interpreting the possibilities themselves (Dreyer/Renn 2009); and "ignorance" – where we don't know what we don't know (Wynne 1992). Each poses more profound challenges for TA than are encompassed in the mere state of risk – which assumes both outcomes and probabilities can be definitively measured (Morgan/Henrion 1990). Yet these crucial lessons are often obscured by the expediently reductive language of probabilistic approaches, as if all forms of incomplete knowledge remain equally tractable to risk assessment. Promoting participation in TA has been proposed as an appropriate response to the uncertainties that characterise technological modernity (Hennen 1999). More recent work has suggested that more explicitly appreciating the distinctions between these contrasting aspects of incomplete knowledge or "incertitude" (Stirling 1998; Stirling/Gee 2002) reveals possible roles for greater diversities of approaches in TA. Some of these have been the object of experiments within

Europe's diverse TA landscape (see for example results from the PACITA project[1] and Ganzevles/van Est 2012, also in this volume).

Other critics have drawn into question the objectivity of technical TA, pointing out that assessments were necessarily dependent on non-technical and often implicit framing assumptions, especially about the nature of the problems prompting assessment, the questions to be asked, the scope of appraisal, the options under consideration, and the appropriate methods to employ in considering them (Wynne 1975).

One response to both the practical challenges of dealing with incertitude and the need to make explicit and interrogate the framing assumptions involved in TA has been to broaden out the inputs to technology assessment (Stirling 2008; Ely et al. 2014). Briefly, broadening out inputs involves extending the scope of a TA exercise in a number of dimensions. An appraisal could, for example, include a greater variety of problem definitions and technological and non-technological options, implementing policies, benefits and impacts, other relevant issues, uncertainties and ambiguities, possibilities and scenarios, values and understandings, and methods of analysis and deliberation. The more even the attention to reasonable alternatives in each of these dimensions, the more broadened out is the particular exercise (Stirling 2008).

These issues of breadth concern the inputs to technology assessment, i.e. the uncertainties, issues, perspectives and options that are included in the appraisal. Another dimension concerns the outputs of TA to policy processes and wider political debates. In comparison to broadening out inputs to TA, opening up its outputs involves not so much the deliberations and analysis that are internal to a given exercise, but the manner in which the eventual findings are communicated and enacted – not only to clients, but also to associated policy-making debates and wider political discourse. Rather than providing a single, ostensibly definitive (objective and comprehensive) characterisation of a technology or related problem (as in old models of TA), an opening up approach delivers a more plural and conditional set of outputs. Each explicitly reflects not only an alternative reasonable recommendation, but also the associated assumptions, circumstances or perspectives (Stirling 2008). In short, this involves the outputs of TA being expressed not as single, ostensibly definitive, results, but as plural and conditional reflections of whatever constitutes the most salient axes of sensitivity that emerge in the analysis. This means highlighting symmetrically a number of in-principle contrasting but equally valid interpretations for appropriate ways forward, each with its associated assumptions, rationales or contexts (Stirling 2010).

Opening up TA can help decision-makers and funders by attending to policy options, issues, uncertainties and perspectives that would otherwise be marginalised. Although not uniquely determining a specific decision, plural and conditional findings can inform political commitments about which kinds of projects to prioritise. And, although not preventing clear political decisions, opening up TA can usefully highlight the benefits of diversity (Stirling 1998; Stirling 2007; Sclove 2010).

These ongoing debates have emerged in very particular governance contexts (characterised by relatively established parliamentary democracy and scientific institutions and by comparatively high average incomes and access to education that seem to assist a positive role for TA). This is not the case in many parts of the world in which public controversies around different technological options form less of a focus of public debate and trans-disciplinary research is less developed. The next section discusses debates beyond the OECD countries, in which most of the TA scholarship and practice has so far been conducted.

3 Technology Assessment in the Context of a Developing Country

Technology assessment has been much less common outside the OECD countries. This is despite longstanding recognition of the dangers of introducing technologies to developing countries without appropriate prior user engagement, assessment or foresight – leading to low uptake, wasted investments and counterproductive consequences (Châtel 1979; Chambers et al. 1989; Goonatilake 1994; Scoones/Thompson 2009). Where it has been conducted in developing countries, TA has tended to have been largely

technical in nature, carried out within centralised institutions or by external consultants to direct government or donor projects. Explicit attention to the diverse priorities and understandings of different stakeholders and citizens has been rare.

This is despite the fact that current appreciations of physical, social and political dynamics in international development (Scoones et al. 2007) call for a more systemic view that attends to multiple and interacting forms of innovation. In the context of a developing country, greater recognition of the implications of complexity, uncertainty and divergent values is necessary in order for TA to explore the plurality of alternative possible "pathways to sustainability" and their associated social and environmental implications (Leach et al. 2010). As discussed above, broadening out the inputs and opening up the outputs of TA can address challenges presented by competing perspectives on innovation-related problems and potential solutions.

The kind of narrowness of TA described above can be especially problematic in lower income countries. Here – despite strenuous and inspiring efforts – the limited capacities of governance mean that the asymmetries of power, privilege and vulnerability often remain more acute. In particular, destitution leads to the exclusion of particular communities. Chronic barriers to educational access and political representation aggravate this marginalisation. These predicaments strongly amplify the rationales for broadening out TA in the ways discussed above. Although not offering panaceas, many methods for broadening out, mentioned above, can help reinforce wider institutional reforms to help extend the range of alternative options and perspectives engaged as inputs to TA and hence help mitigate the ubiquitously distorting effects of privilege and power.

Similarly, the typically greater diversity in developing countries makes it all the more important to open up TA outputs, delivering plural and conditional advice to disparate governmental and non-governmental actors typically involved in development processes. In particular, being explicit about the context specificities, framing assumptions and perspectives upon which the outputs of TA depend can help TA facilitate wider questioning of particular innovations, their transferability to other contexts and the ways in which these are conditioned by power gradients. A further important implication of opening up TA outputs is that careful design can reduce the costs and burdens of more centralised, technical approaches. This is especially important in the setting of an underfunded developing country. The reason is that opening up can relax the pressure to claim that a single TA appraisal is unassailably objective and comprehensive – and to avoid the associated demands for costly (but ultimately futile) pretensions of a definitive analysis.

Limited numbers of participatory TA activities associated with emerging technology and other potential solutions to development challenges have taken place in low income countries. Interest has increased since the 1990s in participatory, "deliberative and inclusionary processes" (DIPs) in areas like the potential role of genetically modified crops in food or fibre production (Wakeford 2001; Wakeford 2004), as carried out in India (ActionAid 2000), Mali (IIED 2007), Zimbabwe (Rusike 2003), and Brazil (Toni/von Braun 2001). Linking across countries in a co-ordinated approach has been relatively rare. We now go on to discuss two case studies that to varying extents displayed tendencies to broaden out and open up TA and were co-ordinated to varying extents across national borders, before reflecting on their implications for institutionalising TA for international development.

4 The International Assessment of Agricultural Knowledge, Science and Technology for Development

The International Assessment of Agricultural Knowledge, Science and Technology for Development, (IAASTD) was a joint initiative of the World Bank, UNDP, FAO, and other institutions. Running between 2003 and 2008, its aim was "to assess the impacts of past, present and future agricultural knowledge, science and technology on the reduction of hunger and poverty, improvement of rural livelihoods and human health, and equitable, socially, environmentally and economically sustainable development" (IAASTD 2009, p. vi). A networked, international multi-stakeholder steering committee established the scope – and

the processes and procedures by which it would be conducted and governed – following consultation with over 800 participants from diverse sectors and locations (Scoones 2009). The assessment was overseen by a multi-stakeholder bureau, which also selected 400 scientists (from a range of disciplines and institutional settings) to author the report. The resulting five regional reports and one global report took four years to produce.

The inclusion of such geographically and sectorally diverse groups (including business, civil society and policy-makers, if not wider citizen participation) had several important consequences. First, it meant that many often-excluded perspectives were voiced – on occasion finding their way into the overall report. As one participant noted: "perhaps for the first time, those advocating sustainable agriculture and indigenous knowledge had been given a place at the table, and got (some of) their views acknowledged" (Scoones 2009). Second, it allowed a range of viewpoints, perspectives, arguments, assumptions and types of evidence to be brought together in one place. One of the key findings of the IAASTD is that there are diverse and conflicting interpretations of the past and current role of agricultural science and technology in development, which need to be acknowledged and respected (IAASTD 2009).

Broadening the scope of IAASTD beyond agricultural science and technology (to include other types of relevant knowledge held by agricultural producers, consumers and end users and to also assess the role of institutions, organizations, governance, markets and trade) led to the options under consideration becoming correspondingly more ambitious and wide-ranging. Attention stretched to include issues such as: the system of agricultural subsidies in the OECD countries; trade rules and intellectual property law; and traditional and local knowledge in community-based innovation. For some, this was too broad: "…if you propose everything, then you don't prioritise anything" observed one commentator (Coghlan 2008).

While the IAASTD process tried to encourage a (broad) plural and inclusive process that genuinely engaged with political and evaluative – as well as technical – issues, it implicitly held an expectation that uncertainties could be resolved (or at least narrowed) by a rational, objective, scientific debate among expert peers, leading to common understandings and consensus visions for the future (Scoones 2009). To some extent, the tension between these contending characteristics was managed through informal debate and argument rather than allowing different political and value positions to be explicitly acknowledged. On particularly contentious issues, such as the potential utility of genetically-modified (GM) crops, consensus was unobtainable and recalcitrant differences of opinion led to the withdrawal of many private sector participants (Nature 2008). Such antagonistic dynamics are not necessarily without value, however the IAASTD did not use the opportunity to explore the worldviews and perspectives that underlay this polarisation or attempt to offer plural and conditional outputs that reflected them.

At the same time, the IAASTD did seek to delineate where there was consensus and where there was uncertainty, and to discuss minority points of view. Furthermore, it did not make unitary recommendations, only a series of options for action at the global level and each of the regional levels, on the basis that different stakeholders who might wish to act on those options have different sets of priorities and responsibilities, and operate in different circumstances. It is difficult to ascertain any concrete impact on funding of agricultural innovation, however the recognition of the multi-functionality of agriculture has been maintained in subsequent internationally-cited reports on similar topics (e.g. Foresight 2011) and thus to a limited extent opened up the debate in this area. An IAASTD spokeswoman argued that "even changing perceptions of farming is quite a shift from the past 50 years, and they should drive the agenda for the next 50" (Coghlan 2008).

5 Exploring the Role of New Technologies in Clean Water Provision Through Stakeholder Events in Zimbabwe, Peru and Nepal

In a rare example of nanotechnology-focussed TA-type activities in developing countries, the international NGO Practical Action joined with other stakeholders to undertake the "Nanodialogue" initiative on clean water provision in

Zimbabwe and a range of related activities in Peru and Nepal. The Zimbabwe event unfolded over three days in 2006, when UK researchers from the think-tank DEMOS and the University of Lancaster gathered in Harare with Practical Action and local stakeholders, scientists and citizens from two communities in Zimbabwe, to investigate the general challenge posed by providing clean water (Grimshaw et al. 2007; Stilgoe 2007; Mellado 2010). The stakeholder workshop approach illustrated by the Zimbabwe nanodialogue was also used in similar exercises co-ordinated by Practical Action to investigate potable water provision in Nepal (Grimshaw 2009) and issues around water and health in Peru (Mellado 2010). The focus of the current analysis, however, is on the Zimbabwe exercise.

As part of a larger, UK government-supported programme of nanodialogues, the process was organised around the question "can nanotechnologies help achieve the millennium development target of halving the number of people without access to clean water by 2015?" However, it focussed on identifying and understanding various sources of problems in water provision, as well as discussing a number of potential technological and non-technological solutions, with nanotechnologies included as just one option among many. By including academics from the Zimbabwean Academy of Sciences and UK and South African universities, representatives from several Zimbabwean Ministries and many other public agencies, and by directly involving communities in a participatory process, the Zimbabwe nanodialogue broadened out both technical and non-technical inputs to the process. Addressing not only technological, but also cultural and political issues in discussion, it also delivered a number of general recommendations to government and non-government actors, both national and international.

The process also included members of two different citizen communities, crucially differentiating perspectives, rather than seeing "users" as a uniform group. This enabled attention to be paid to a diversity of contexts in which nanotechnologies might be employed – with issues such as control and ownership put forward as key issues for consideration in ways that might otherwise have been neglected. Organisers concluded that the inclusion of policy-makers and other innovation system actors at the workshop led to a greatly improved understanding and capacity than would have been the case for a less participatory TA exercise.

Despite being named a nanodialogue, the scope of the Zimbabwe TA-like exercise focused on diverse policy responses to water challenges, looking well beyond nanotechnology. Indeed, the shared finding emerged after the first two days that "there is no real water quality issue that cannot be solved with existing technologies" is itself an illustration of a kind of opening up that would be impossible under a more singular focus on a particular technology. However, the final outputs of the nanodialogue were not limited to this consensus. Discussions raised a large number of further questions, including those targeted at scientists about the possibility of using nanotechnologies in combination with other options, as well as the timeframes and specific conditions under which these might be favourable. The inclusion in the report of unresolved questions, ambiguities and uncertainties, alongside more specific findings and recommendations, also provided a more open basis for future societal discussion. This may not have helped bring about direct policy change (and to some extent subsequent investment was in any case precluded by the context). But the process highlighted the complexities of, and alternatives to, the focal set of new technologies.

6 Lessons for New Institutional Models of TA for International Development

Based on this evidence, what implications arise for new TA institutions, especially those focussing on international development challenges with a global dimension? In particular, what can these examples suggest for institutionalised approaches in developing countries? Here, a number of lessons emerge for the design and implementation of TA institutions for international development. Taken together with other studies in this area (e.g. PACITA), these suggest the following:

- TA exercises are best viewed in context – as crucial elements in wider processes of social appraisal. The key role of TA, therefore, is not to undertake the entire task of justifying tech-

nological decisions, but to catalyse, inform, enable and strengthen these broader social and political processes.

- There are synergies – not just tensions – between participatory and expert-led approaches to TA. Broad, participatory approaches directly address challenges of framing the problems and options to be addressed – with outputs offering usefully to inform more traditional expert-based analysis.
- The networked, multi-actor example offered by exercises like the IAASTD can offer a more flexible and agile approach that allows conversations across disciplinary, technological and sectoral domains (vital to respond to the complex challenges of sustainable development).
- Drawing on external sources of knowledge and experience beyond a central TA office may be particularly advantageous in developing country settings, where in-house expertise and capacity may be especially lacking. Within a networked approach, the core role (for example of a government agency) centres on co-ordinating, rather than conducting, TA.
- Capacities in methods and practices for these kinds of TA are often lacking in many developing countries. Data and statistics that can inform TA activities are also often scarce. Here, appropriate pooling of resources between countries may enable more effective TA. At the same time, capacity within co-ordinating institutions is a prerequisite to developing networked approaches.
- Resources and capacity may often also be lacking for effective political decision making in response to TA. Acknowledgement of these realities forms an integral part of the quality of openness, not least to avoid disillusionment and disrespect of participants. Nevertheless, the broadening out and opening up of TA described here may generate tacit learning within wider innovation systems, even if particular outputs do not become explicit bases for concrete decisions.
- There is a need to move beyond a series of unconnected, isolated TA experiments, towards more coherently-co-ordinated (but still diverse) internationally-networked approaches, allowing participatory TA to be scaled up in wider areas of the world. The focus should therefore not just be on specific TA exercises in particular settings, but also on broader trans-national programmes, in order to enable cumulative distributed learning about contending innovation imperatives and possibilities and the associated appropriate TA processes.

It is easy to speculate on the potential institutional sites in which internationally networked technology assessment could be based. However, the evidence base for any such proposals is absent. There are very few cases where citizen perspectives have been sought to inform policy making in a co-ordinated way beyond OECD countries (see for example Worldwide Views on Global Warming[2] which involved exercises in 38 nations and was co-ordinated by the Danish Board of Technology, although not in TA *per se*). International associations focussing on technology assessment (with geographic spread beyond that of the European Parliamentary Technology Assessment[3] or earlier attempts such as the International Association of Technology Assessment and Forecasting Institutions), NGOs (e.g. the International Center for Technology Assessment; http://www.icta.org) and intergovernmental organisations (UN Commission for Science, Technology and Development) could all have roles to play. Key to the efficacy of such institutional arrangements, however, will be their governance structures and articulation with the wider innovation systems in which they would need to be embedded.

Indeed, the most crucial systemic requirements for effective broadening out and opening up of TA are the same qualities towards which this arguably contributes: more responsive relations in the governance of innovation between business, academia, government and civil society. By this means, the broader and more open forms of TA advocated here offer ways to help enhance both technical robustness and societal relevance in global innovation systems. Only by enabling these more networked and internationally co-ordinated kinds of TA might the formidable energies of worldwide innovation systems become more socially equitable, environmentally sustainable and democratically legitimate.

Notes

1) http://www.pacitaproject.eu/
2) http://www.wwviews.org
3) http://www.eptanetwork.org

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